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#14 Appeal Brief
M. Braunsn
5/13/03

In re Application of:
Douglas W. Hall And Mark Newhouse
Confirmation No.: 5745
Serial No.: 09/105,572
Group Art Unit: 2874
Filing Date: June 26, 1998
Examiner: Hemang Sanghavi
For: "Fiber Amplifier Having Modified Gain Spectrum"

DATE OF DEPOSIT: 4-16-03

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Assistant Commissioner for Patents
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Sir:

APPEAL BRIEF UNDER 37 C.F.R. § 1.192

This Appeal Brief is in support of Appellant's appeal from the final rejection of claims 21-50, dated October 21, 2002 and the Advisory Action dated February 19, 2003 affirming the final rejection. A Notice of Appeal was filed on February 20, 2003.

A. REAL PARTY IN INTEREST

Corning Incorporated is the real party in interest in the present application.

B. RELATED APPEALS AND INTERFERENCES

There are no related appeals.

Interferences were declared between the applicants' original patent and a reissue application of Grasso et al., U.S. Patent No. 5,087,108. The patent was assigned to Societá Cavii Perilli S.p.A., but the reissue application is now assigned to Corning O.T.I. SPA, a company related to Corning Incorporated.

C. STATUS OF CLAIMS

Claims 21-50 were rejected in the Final Rejection mailed October 21, 2002. Claims 21, 22, 30, 32-34, and 37-38 were rejected as unpatentable over the lost Count 1 in the interference on the grounds of estoppel. Claims 21, 22, 30 and 32-34 have been canceled. Examiner states: "The only difference between these claims and the count 1 is that the gain fiber is limited to a fiber 'having only one single-mode core' in contrast to count 1 which includes a gain fiber having **a** single-core". (page 3 of 10/21/2000 Official Action).

Claims 39-40 were rejected as unpatentable over the lost count 2 on the grounds of estoppel. Examiner made the same statement with regard to the difference between the claims and the count.

Claims 41-43 were rejected as unpatentable over the lost counts on the grounds of estoppel. Examiner states that the only difference between the interference count 1 and these claims is that the claims further define the gain spectrums of the gain fiber and ion filtering means over the wavelength bands. Examiner contends that performing routine experimentation, the ordinary artisan would have found it obvious to draw out the gain spectrum of the gain fiber and the filtering means of count 1. Examiner further states that the difference between the interference count and claim 43 is that this claim further defines the gain spectrums of the gain fiber and filtering means over the wavelength bands.

Claims 44-50 were rejected as unpatentable over the lost count 1 on the grounds of estoppel further in view Grasso et al., U.S. Patent 5,245,467. Examiner states that the difference between lost count 1 and these claims is that the claims further define the gain spectrums and the gain filter and filtering means over the predetermined wavelength bands. Examiner contends that performing routine ordinate experimentation the ordinary artisan would have found it obvious to draw out the gain spectrum of the gain fiber and the filtering means.

Claims 21-50 were rejected because of a defective reissue Declaration. Examiner asserts that the error which is relied upon is not an error upon which a reissue can be based.

Claims 44-50 were rejected under 35 U.S. C. § 251 as being broadened in a reissue application filed outside the two year statutory period.

D. STATUS OF THE AMENDMENTS

An amendment canceling claims 21-30 was filed subsequent to the Final Rejection. (The amendment should have cancelled claims 21-34 to include all claims dependent from

claim 21. This amendment was entered for purposes of appeal in the Advisory Action of February 19, 2003. Claims 35-50 are presented for appeal. These claims, as amended, are set forth in an appendix.

E. SUMMARY OF THE INVENTION

The claimed invention is directed to optical fiber amplifiers which selectively attenuate unwanted wavelengths of light.

As shown in Figure 1 a gain fiber 10 has a core which is doped with gain ions that produce stimulated emission of light at a signal wavelength λ_s when pumped with light at a pump wavelength λ_p. . (Col. 3, lines 1-9 of the Hall et al. application.) A signal to be transmitted is coupled through coupler 11 from input fiber 14 to the gain fiber 10 at the signal wavelength λ_s. Pump light at wavelength λ_p from laser diode 15 is coupled through coupler fiber 12 to the gain fiber 10. In order to modify the gain spectrum of the fiber amplifier, an absorbing ion filter 17 is provided. The filter 17 absorbs, or attenuates, some of the light within the band of wavelength including the pump signal wavelength λ_s.

As an example, an erbium-doped fiber amplifier is frequently used in communication systems operating at 1550 nm. Absorbing filter 17 attenuates, or reduces, the 1532 nm peak.

As shown in Figure 2, in the erbium example, the absorbing ion filtering means 17 attenuates the gain around the wavelength of 1550 nm and particularly attenuates the peak 23 at 1532 nm. This provides better signal transmission because the amplifier has a band centered on 1550 nm, the operating wavelength. Signal transmission in this narrow band is not wavelength dependent. (See column 3, line 57 through column 4, line 24 of the Hall et al. patent, the reissue application.)

Other embodiments which have this important advantage are shown in Figures 3, 4, 8-14 and 16-19.

The distinguishing feature of the invention which is claimed herein is that in all embodiments the gain fiber has only one signal mode core.

The technique of fabricating optical fibers is described in column 3, lines 22-43 of the Hall et al. application. In this fabrication technique a core pre-form is coated with cladding glass. A significant reduction in the complexity in fabrication can be achieved by fabricating an optical fiber with only a single core. If more than one core must be provided, the fabrication is more difficult. The invention which is claimed in this application achieves the advantage of easy fabrication without losing the function of attenuating light within a

predetermined band of wavelength.

ARGUMENT

A. THE GRASSO ET AL. PATENT

The Grasso patent also relates to an optical fiber amplifier. As an example, Grasso presents the same erbium-doped fiber having an emission peak at 1536 nm, and emission waveband 1520 to 1570 nm. (Column 2, lines 41-48 of the Grasso et al. application.)

Grasso also has the object of attenuating, or preventing, spontaneous emissions at an undesired wavelength. (Column 3, lines 21-30.). The difference between Hall et al. and Grasso et al. is that Grasso et al. achieves the desired attenuation by providing two cores in the fiber. The two cores are designated 11 and 12 in Figs. 4, 5, and 7 and 101 and 102 in Figure 8. Grasso states:

> "..(i)In accordance with the present invention provision has been made for the use of an active fiber of the type shown in cross-sectional view in FIGS. 4 and 5 which has two cores, 11 and 12 respectively, enclosed by the same cladding 13." (Column 5, lines 41-45.)

In order to fabricate the Grasso fiber, it is necessary to dope the pre-form with two core forming materials surrounded by cladding material. Then when the pre-form is drawn into a fiber it will have the two cores as shown in the Grasso drawings. Grasso does not have any disclosure of how to perform the function of selective attenuation in a single core fiber. Quite the contrary, Grasso teaches away from a single core fiber. Starting at the bottom of column 8, Grasso et al explain an example in which a double core fiber 6 is doped with erbium which was distributed in equal parts in the two cores 11 and 12. For comparison the same amplifier was constructed with a fiber having a single core. (Column 9, line 33.) Grasso et al. describe the single core amplifier as follows:

> "As can be seen from the above examples, while an amplifier with a single-core fiber has shown a reduced gain in the presence of a 1560 nm wavelength signal, also introducing such a noise that the signal reception was difficult, so that said amplifier was practically useless..." (Column 10, lines 56-61.)

The claims at issue here could not have been placed in interference with the Grasso et al. patent because the Grasso disclosure does not support the limitation that the gain fiber has

only one single mode core.

B. ESTOPPEL DOES NOT BAR HALL ET AL. FROM CLAIMING A PATENTABLY DISTINCT INVENTION

Estoppel based on the lost counts of an interference is based upon 37 CFR §1.658 (c). That section provides that a losing party who could have properly moved but failed to move under sections §§ 1.633 or 1.634, is estopped to take *ex parte* or *inter partes* action in the Patent and Trademark Office after the interference which is inconsistent with that party's failure to properly move.

Claims 35-50 were added to this application in a Preliminary Amendment filed June 26, 1998. The REMARKS of that amendment referred to the original Hall 069 patent which was involved in interference. The REMARKS also referred to the Grasso patent as having a "double core" fiber. The newly submitted claims could not be added to the interference because Grasso et al. did not have support for claims reciting "only a single core". Hall et al. has consistently argued that the single core fiber recited in claims 21-50 was patentably distinct from the "double core" fiber of Grasso et al.

The only actions *in ex parte* prosecution that Rule 658 (c) proscribes are those that are *inconsistent* with a party's failure to file a motion in an interference under Rules 633 or 634:

> A losing party who could have properly moved, but failed to move, under § 1.633 or 1.634, shall be estopped to take *ex parte* or *inter parte* action in the Patent and Trademark Office after the interference *which is inconsistent with that party's failure to properly move*(37 CFR § 1.658(c), emphasis added).

Applicants' pursuit of claims 35-50 is entirely ***consistent*** with the above-noted absence of interference-related activity. Indeed, by not seeking to have these claims added to Interferences 104,069 and 104, 075 or made the subject of another interference against Grasso, *et al.*, Applicants were adopting precisely the same position that they are adopting here – *i.e.*, that the claimed subject matter is patentably distinct from the subject matter of

Interferences 104,069 and 104,075 and from the Grasso, *et al.*, patent. Applicants are entitled to make a showing in the instant application that the presently claimed invention is not substantially the same as that of the lost count of interferences 104, 069 and 104, 075.

> A losing party to an interference is entitled to claim subject matter other than that of the interference count, provided the requirements of patentability are met, and subject to those constraints that flow from the adverse decision in the interference. *In Zletz,* 13 USPQ 2d 1320, 1322 (Fed. Cir. 1989).

The estoppel provision of Rule 658(c) is plainly inapplicable. Applicants therefore respectfully request that the rejection of claims 35-50 due to alleged estoppel be reconsidered and withdrawn.

The patentability of claims 35-50 in view of the Grasso patent must be considered.

C. THE INVENTION CLAIMED HERE IS PATENTABLY DISTINCT FROM THE GRASSO ET AL. PATENT

1. The Grasso et al. Patent Teaches Away From Making An Amplifier With A Single Core Gain Fiber

The Grasso et al. patent states that an amplifier having a single core gain fiber which they produced for comparison with their example fiber introduced such noise that signal reception was difficult so that the amplifier was "practically useless". (Co. 10, lines 56-61.) This a textbook case of teaching away from the invention which Hall et al. had made. See **MPEP § 2145 X. D. References teach away from the invention or render prior art unsatisfactory for intended purpose and In re Hedges** 783 F 2d 1038 1041 (Fed. Cir. 1986.

In **Hedges** the claim at issue related to a process for preparing sulfonic acids. The prior art references taught that lower temperatures of reaction are preferable. **Hedges** claimed a reaction in the molten state. The prior art taught away from the claimed invention of carrying out the reaction in the molten state. This was strong evidence of unobviousness citing *W. L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F. 2d 1540, 1552, 220 USPQ 303,

312 (Fed. Cir. 1983), *cert. denied,* 105 S. Ct. 172 (1984), citing *United States v. Adams,* 383 U.S. 39, 148 USPQ 479 (1996). **Hedges 783 F 2d 1041 (Fed. Cir. 1986.)**

In the present case Grasso et al. states that only a double core fiber will provide the desired attenuation characteristics. Hall et al. claims using a fiber with a single-core. The claimed invention is unobvious.

2. Hall et al. Have Retained The Function Of Selected Attenuation While Eliminating A Core.

The amplifier claimed herein has "only one single-mode core" but it still performs the function of selected attenuation.

The MPEP states at §2144.04:

> **II. ELIMINATION OF A STEP OR AN ELEMENT AND IT'S FUNCTION**
>
> ...
>
> **B. Omission of an Element with Retention of the Element's Function Is an Indicia of Unobviousness**
>
> Note the omission of an element and <u>retention</u> of its function is an indicia of unobiousness. *In re Edge,* 359 F. 2d 896, 149 USPQ 556 (CCPA 1966)(emphasis is in the original).

In **Edge** the claims were directed to a printed sheet having a thin layer of erasable material bonded directly to the sheet whereas the prior art disclosed a similar printed sheet with an intermediate transparent layer between the sheet and the layer of erasable material. **Edge** eliminated the transparent layer but maintained the function of erasing the middle layer without erasing the printed indicia. Similarly, in the present case, Hall, et al. have eliminated a core in the gain fiber, but have retained the function of selectively attenuating certain wavelengths of light. This is an indicia of unobviousness.

D. The Reissue Declaration is not Defective

Claims 35-40 correspond exactly to the original claims 15-20, except that the "gain optical fiber" is now limited to a fiber "having only one single-mode core" as contrasted to

the original claim limitation "having a single-mode core." It is noted in the Declaration that the original claim limitation could have raised a question as to whether claims 1-20 were limited to a structure having only one core. This is an error which can be corrected by reissue.

To obviate any questions, patentees have presented the claims at issue here. Claims 41-43 are substantially the same as original claims 1, 17 and 19, but are limited to a structure having only one core. Such a structure is clearly set forth in the original patent specification and drawings, e.g., see Figs. 1, 4, 10 and 11 and at column 3, line 38, and at column 4, line 67, for example. No new matter is added. Claims 41-43 also differ from the original claims in calling for a fiber amplifier having a flattened gain spectrum. (See column 1, line 20 of Hall et al. reissue application.) The Supplemental Combined Reissue Application Declaration filed in this application specifically states that the original patent is partly inoperative because [1] the original patent issued without claims specifically directed to an amplifier having only one single mode core; and [2] it was error to permit the original patent to issue without having claims specifically directed to a fiber amplifier having a flattened gain spectrum. Again, these are errors which are correctible by reissue. The reissue declaration is not defective. It correctly recites the errors.

New claims 44-50 recite all of the limitation of the original claims and additional recite that the gain optical fiber consists of one core. These claims more specifically recite the wave lengths in which the gain spectrum is flattened. The reissue declaration correctly recites these errors.

The Reissue Declaration and the Supplemental Declaration more than adequately recite the error upon which the reissue application is based.

E. Claims 35-50 Are Not Broader In Any Respect Than the Original Claims.

Claims 35-50 are modifications of original patent claims. The modifications can best be seen in Appendix A wherein the words deleted from those original claims are in brackets and the added words are in bold face type. The only matter deleted from the claims relates to inconsequential matters which have been deleted to better define the claimed subject matter. There is no broadening of the claims. Support for the added matter appears in the footnotes to those claims in Appendix A.

Examiner states "Claims 44-50 do not recite a single mode core and an excitation preventing means as claimed in original independent claim 1." (Final Rejection, page 6.) Instead of reciting "a single mode core", the claims recite "only one single mode core". This is a narrower recitation, not a broadened recitation. With respect to the "excitation preventing means" this was recited only in original independent claim 1, not in independent claims 15, 17, and 19. Clams 44-50 are like original claims 15-20 but are narrower. The claims are narrower in all respects. Examiner's contends that the "Claims are narrower in some aspects, however these claims are broader in the aspect of lacking an excitation preventing means and a gain fiber with a single mode core". (Final Rejection. page 6.) Claims 44-50 are narrower, in reciting "only one" single mode core. The excitation preventing means of claim 1 is recited in more detail in the last clause of claim 44. This states that the gain ions of the pump light attenuating fiber remain unexcited. This is not broader in scope than claim 1. It is the same scope as original claim 15.

Applicants have not added new matter to the added claims and have not expanded the scope of any beyond the scope of the original patent claims 1-20.

The foregoing is well recited as the error which is relied upon in the Reissue Declaration.

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APPENDIX A
For Appeal Brief

Clarification of Claims 41-50

[1] 41. A fiber amplifier having a flattened gain spectrum[1] comprising

a gain optical fiber having [a] only one single-mode core, said core containing dopant ions capable of producing a gain spectrum due to stimulated emission of light within a predetermined band of wavelengths including a wavelength λ_s when pumped with light of wavelength λ_p, said gain fiber having input and output ends, and wherein the gain spectrum of said gain optical fiber over said band of wavelengths has a first portion having a relatively small gain variation over a region of said band wavelengths and a second portion having a relatively large gain variation over a different region of said band wavelengths, wherein said first portion of the gain spectrum is relatively flat and wherein said second portion is not flat and exhibits and exhibits a greater gain than the gain exhibited over said relatively flat portion[2];

[absorbing] ion filtering means for [attenuating]

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[1] Col. 1, lines 20, 65-68.

[2] Col. 3, lines 64-67, and Figs. 2, 5-7.

absorbing light within said predetermined band of wavelengths, said [absorbing] ion filtering means having an absorption spectrum having a first portion exhibiting relatively small absorption over said region of said band of wavelengths and a second portion having a relatively large absorption of said different region of said band of wavelengths where the gain spectrum is not flat, said ion filtering means comprising a concentration and distribution of umpumped gain ions within said ion filtering means wherein amplified light having wavelengths within said predetermined band of wavelengths where the gain spectrum is not flat is attenuated to an extent such that the gain spectrum over the entire predetermined band of wavelengths is flattened and exhibits relatively small gain variation over said entire band of wavelengths[3];

means for introducing a signal of wavelength λ_S into said gain fiber input end,

means introducing pump light of wavelength λ_P into said gain fiber, and

means for preventing the excitation of said pumped gain ions by light of wavelength λ_P.

[17] **42.** A fiber amplifier comprising

a gain optical fiber having [a] **only one** single-mode

[3] Col.4, lines 16-48; col. 5, lines 2-17; col. 6, line 61, and col. 7, line 14; and Figs5-6.

core, said core containing dopant ions capable of producing stimulated emission of light within a predetermined band of wavelengths including a wavelength λ_s when pumped with light of wavelength λ_p, said gain fiber having input and output ends, and **wherein the gain spectrum of said gain optical fiber, over said band of wavelengths and when pumped with light from wavelength λ_p has a first portion which is relatively flat and a second portion which is not flat and exhibits gain greater than the gain exhibited over said relatively flat portion**[4];

filtering means for attenuating light at at least some of the wavelengths within said predetermined band of wavelengths, said filtering means containing ions that can be excited by light of wavelength λ_p, **said filtering means having a transmission curve over said predetermined band of wavelengths and in the absence of excitation by said gain fiber over said predetermined band of wavelengths when said gain fiber is excited by light at wavelength λ_p so that when light in the range of said predetermined range of wavelengths is amplified and filtered by said filtering means, the resulting gain spectrum for said amplifier over said predetermined range of wavelengths is substantially flat**[5];

means for introducing a signal of wavelength λ_s into

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[4] See footnote 2.

[5] See footnote 3.

said gain fiber input end,

means introducing pump light of wavelength λ_p into said gain fiber, and

means for preventing the excitation of said filtering means by light of wavelength λ_p.

[19] **43.** A fiber amplifier comprising

a gain optical fiber having [a] **only one** single-mode core, **said core** containing dopant ions capable of producing stimulated emission of light within a predetermined band of wavelengths including a wavelength λ_s when pumped with light of wavelength λ_p, said gain fiber having input and output ends, said dopant ions being selected from the group consisting of erbium, neodymium and praseodymium, **and wherein the gain spectrum of said gain optical fiber, over said band of wavelengths and when pumped with light from wavelength λ_p has a first portion which is relatively flat and a second portion which is not flat and exhibits gain greater than the gain exhibited over said relatively flat portion**[6];

filtering means for attenuating light at at least some of the wavelengths within said predetermined band of wavelengths, said filtering means containing a dopant selected from the group consisting of erbium, dysprosium, neodymium, ytterbium, samarium,

[6] See footnote 2.

praseodymium, thulium, vanadium and cadmium selenide, said filtering means having a transmission curve over said predetermined band of wavelengths and in the absence of excitation by said gain fiber over said predetermined band of wavelengths when said gain fiber is excited by light at wavelength λ_p so that when light in the range of said predetermined range of wavelengths is amplified and filtered by said filtering means, the resulting gain spectrum for said amplifier over said predetermined range of wavelengths is substantially flat[7];

means for introducing a signal of wavelength λ_S into said gain fiber input end, and

means introducing pump light of wavelength λ_p into said gain fiber.

<u>New Claims 44-50</u>

44. An optical fiber amplifier having a flattened gain spectrum for use over a wavelength range of about 1530 to about 1560nm comprising:

a gain optical fiber consisting of one core, said containing ions capable of producing stimulated emission of light within the band of wavelengths extending from about 1530 to about

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[7] See footnote 3.

1560nm when pumped with light having a wavelength capable of causing said stimulated emission in said band of wavelengths, said stimulated emission from said gain fiber exhibiting a gain spectrum including a peak around 1532nm and a substantially flat gain region extending from about 15460nm to about 1560nm, said gain fiber having input and output ends;

a gain spectrum fiber exhibiting an absorption spectrum and having an input end and an output end, one of the input and output ends of said filtering fiber being optically connected to one of the output and input ends, respectively, of said gain fiber, said filtering fiber having a core doped with ions which are capable of absorbing light according to said absorption spectrum within the band of wavelengths extending from about 1530 to about 1560nm, the absorption spectrum of said filtering fiber having a substantially non-flat absorption spectrum in the spectral region from about 1530 to about 1540nm and particularly at about 1532nm and having a relatively flat absorption spectrum in the region from about 1540 to about 1560nm, the absorption spectrum exhibiting a lower absorption in the region from about 1540 to about 1560nm than the absorption in the spectral region from about 1530 to about 1540nm and particularly at about 1532nm, one of the input and output ends of said filtering fiber being adapted for connection to a transmission fiber input end;

means for introducing pump light into at least one of the input and output ends of said gain fiber; and

means for introducing a light signal having a wavelength in the range from about 1530 to about 1560nm into the input end of said gain fiber wherein said pump light stimulated emission in said gain fiber over the wavelength range from about 1530 to about 1560nm and an amplified signal in the range from about 1530 to about 1540nm is not attenuated below a level about equal to the magnitude of an amplified signal in the wavelength range from about 1540 to about 1560nm[8].

45. The amplifier of claim 44 wherein said means for introducing pump light comprises at least two pump sources[9].

46. The amplifier of claim 44 wherein said amplifier is reverse pumped[10].

47. The amplifier of claim 44 which further comprises means between said gain fiber and said filtering fiber for filtering light in the pump wavelength spectrum[11].

48. The amplifier of claim 44 wherein the pump

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[8] Col. 1, lines 1-9; col. 3, lines 66-68; col. 4, lines 17-49; col. 5 lines 2-16 and line 66, to col. 6, line 8; col. 7, lines 59-60; and Figs. 1, 4, 10-12.

[9] Col. 6, lines 48-60.

[10] See footnote 9.

[11] Col. 4, lines 48-66; col. 5, line 29, to col. 6, line 8.

light has a wavelength centered around at least one of about 980nm and 1480nm[12].

49. The amplifier of claim 45 wherein the at least two pump sources have a wavelength centered around at least one of about 980nm and 1480nm[13].

50. The amplifier of claim 45 further comprising at least a second gain optical fiber consisting of one core which contains ions capable of producing stimulated emission of light within the band of wavelengths extending from about 1530 to about 1560nm when pumped with light having a wavelength capable of causing said stimulated emission in said band of wavelengths, said stimulated emission from said gain fiber exhibiting a gain spectrum including a peak around 1532nm and a substantially flat gain region extending from about 1540nm to about 1560nm, said second gain fiber having input and output ends; wherein said at least first and second gain fibers and said filtering fiber are optically interconnected in a series arrangement[14].

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[12] Col. 5, lines 44-45, and Table 1.

[13] See footnote 12 and col. 5, line 64, to col. 6, line 60.

[14] Col. 6, lines 9-36, and Fig. 10.

APPENDIX B
for Appeal Brief

Claims 35-50 as Amended

35. A fiber amplifier comprising

a gain optical fiber having only one single-mode core, said core containing gain ions capable of producing stimulated emission of signal light within a predetermined band of wavelengths including a wavelength λ_S when pumped with pump light of wavelength λ_P, said gain fiber having first and second ends,

a filtering fiber containing gain ions for filtering signal light,

a pump light-attenuating fiber having a core containing a dopant that attenuates said pump light while signal light remains substantially unattenuated, said pump light-attenuating fiber connecting the second end of said gain fiber to an end of said filtering fiber,

means for introducing pump light of wavelength λ_P into the first end of said said gain fiber,

and means for introducing a signal of wavelength λ_S into one of the ends of the series combination of said gain fiber, said pump light-attenuating fiber and said filtering fiber, the gain ions of said filtering fiber remaining unexcited during operation because of the pump light filtering action of said pump light-attenuating fiber, whereby said filtering fiber alters the spectral gain of said amplifier.

36. A fiber amplifier comprising

first and second gain optical fiber sections, each having only one single-mode core, said core containing dopant ions capable of producing stimulated emission of light within a predetermined band of wavelengths including a wavelength λ_S when pumped with light of wavelength λ_P, each gain fiber section having first and second ends,

first and second pump light-attenuating fiber sections, each having a core containing a dopant that attenuates optical power in at least one wavelength band including said wavelength λ_P, while optical power at said wavelength λ_S remains substantially unattenuated thereby, each pump light-attenuating fiber section having first and second ends, the first end of each of said pump light-attenuating fiber sections being spliced to a respective one of the second ends of said gain fiber sections,

a filtering fiber, the ends of which are respectively connected to the second ends of said pump light attenuating fiber sections, said filtering fiber being doped with gain ions,

means for introducing pump light of wavelength λ_P into the first end of each of said gain fiber sections, and

means for introducing a signal of wavelength λ_S into the first end of one of said gain fiber sections, the gain ions of said filtering fiber remaining unexcited during operation because of the pump light filtering action of said pump light-attenuating fiber.

37. A fiber amplifier comprising

a gain optical fiber having only one single-mode core, said core containing dopant ions capable of producing stimulated emission of light within a predetermined band of wavelengths including a wavelength λ_S when pumped with light of wavelength λ_P, said gain fiber having input and output ends,

filtering means for attenuating light at at least some of the wavelengths within said predetermined band of wavelengths, said filtering means containing ions that can be excited by light of wavelength λ_P,

means for introducing a signal of wavelength λ_S into said gain fiber input end,

means introducing pump light of wavelength λ_P into said gain fiber, and

means for preventing the excitation of said filtering means by light of wavelength λ_P.

38. A fiber amplifier in accordance with claim 37 wherein said gain fiber is co-doped with signal light absorbing ions that are different from said gain ions.

39. A fiber amplifier comprising

a gain optical fiber having only one single-mode core, said core containing dopant ions capable of producing stimulated emission of light within a predetermined band of wavelengths including a wavelength λ_S when pumped with light of wavelength λ_P, said gain fiber having input and output ends, said dopant ions being selected from the group consisting of erbium, neodymium and praseodymium,

filtering means for attenuating light at at least some of the wavelengths within said predetermined band of wavelengths, said filtering means containing a dopant selected from the

group consisting of erbium, dysprosium, neodymium, ytterbium, samarium, praseodymium, thulium, vanadium and cadmium selenide,

means for introducing a signal of wavelength λ_S into said gain fiber input end, and

means introducing pump light of wavelength λ_P into said gain fiber.

40. A gain amplifier in accordance with claim 39 wherein said filtering means comprises an optical fiber containing said dopant ions.

41. A fiber amplifier having a flattened gain spectrum comprising

a gain optical fiber having only one single-mode core, said core containing dopant ions capable of producing a gain spectrum due to stimulated emission of light within a predetermined band of wavelengths including a wavelength λ_S when pumped with light of wavelength λ_P, said gain fiber having input and output ends, and wherein the gain spectrum of said gain optical fiber over said band of wavelengths has a first portion having a relatively small gain variation over a region of said band wavelengths and a second portion having a relatively large gain variation over a different region of said band wavelengths, wherein said first portion of the gain spectrum is relatively flat and wherein said second portion is not flat and exhibits a greater gain than the gain exhibited over said relatively flat portion;

ion filtering means for absorbing light within said predetermined band of wavelengths, said ion filtering means having an absorption spectrum having a first portion exhibiting relatively small absorption over said region of said band of wavelengths and a second portion having a relatively large absorption of said different region of said band of wavelengths where the gain spectrum is not flat, said ion filtering means comprising a concentration and distribution of umpumped gain ions within said ion filtering means wherein amplified light having wavelengths within said predetermined band of wavelengths where the gain spectrum is not flat is attenuated to an extent such that the gain spectrum over the entire predetermined band of wavelengths is flattened and exhibits relatively small gain variation over said entire band of wavelengths;

means for introducing a signal of wavelength λ_S into said gain fiber input end,

means introducing pump light of wavelength λ_P into said gain fiber, and

means for preventing the excitation of said pumped gain ions by light of wavelength λ_P.

42. (Amended) A fiber amplifier comprising

a gain optical fiber having only one single-mode core, said core containing dopant ions capable of producing stimulated emission of light within a predetermined band of wavelengths including a wavelength λ_S when pumped with light of wavelength λ_P said gain fiber having input and output ends, and wherein the gain spectrum of said gain optical fiber, over said band of wavelengths and when pumped with light from wavelength λ_P, has a first portion which is relatively flat and a second portion which is not flat and exhibits gain greater than the gain exhibited over said relatively flat portion;

filtering means for attenuating light at at least some of the wavelengths within said predetermined band of wavelengths, said filtering means containing ions that can be excited by light of wavelength λ_P, said filtering means having a transmission curve over said predetermined band of wavelengths and in the absence of excitation by said gain fiber over said predetermined band of wavelengths when said gain fiber is excited by light at wavelength λ_P so that when light in the range of said predetermined range of wavelengths is amplified and filtered by said filtering means, the resulting gain spectrum for said amplifier over said predetermined range of wavelengths is substantially flat;

means for introducing a signal of wavelength λ_S into said gain fiber input end;

means introducing pump light of wavelength λ_P into said gain fiber; and

means for preventing the excitation of said filtering means by light of wavelength λ_P.

43. (Amended) A fiber amplifier comprising

a gain optical fiber having only one single-mode core, said core containing dopant ions capable of producing stimulated emission of light within a predetermined band of wavelengths including a wavelength λ_S when pumped with light of wavelength λ_P, said gain fiber having input and output ends, said dopant ions being selected from the group consisting of erbium, neodymium and praseodymium, and wherein the gain spectrum of said gain optical fiber, over said band of wavelengths and when pumped with light from wavelength λ_P has a first portion which is relatively flat and a second portion which is not flat and exhibits gain greater than the gain exhibited over said relatively flat portion;

filtering means for attenuating light at at least some of the wavelengths within said predetermined band of wavelengths, said filtering means containing a dopant selected from the

group consisting of erbium, dysprosium, neodymium, ytterbium, samarium, praseodymium, thulium, vanadium and cadmium selenide, said filtering means having a transmission curve over said predetermined band of wavelengths and in the absence of excitation by said gain fiber over said predetermined band of wavelengths when said gain fiber is excited by light at wavelength λ_P so that when light in the range of said predetermined range of wavelengths is amplified and filtered by said filtering means, the resulting gain spectrum for said amplifier over said predetermined range of wavelengths is substantially flat;

means for introducing a signal of wavelength λ_S into said gain fiber input end; and

means introducing pump light of wavelength λ_P into said gain fiber.

44. (Amended)An optical fiber amplifier having a flattened gain spectrum for use over a wavelength range of about 1530 to about 1560nm comprising:

a gain optical fiber having only one core, said core containing ions capable of producing stimulated emission of light within the band of wavelengths extending from about 1530 to about 1560nm when pumped with light having a wavelength capable of causing said stimulated emission in said band of wavelengths, said stimulated emission from said gain fiber exhibiting a gain spectrum including a peak around 1532nm and a substantially flat gain region extending from about 15460nm to about 1560nm, said gain fiber having input and output ends;

a filtering fiber exhibiting an absorption spectrum and having an input end and an output end, one of the input and output ends of said filtering fiber being optically connected to one of the output and input ends, respectively, of said gain fiber, said filtering fiber having a core doped with ions which are capable of absorbing light according to said absorption spectrum within the band of wavelengths extending from about 1530 to about 1560nm, the absorption spectrum of said filtering fiber having a substantially non-flat absorption spectrum in the spectral region from about 1530 to about 1540nm and particularly at about 1532nm and having a relatively flat absorption spectrum in the region from about 1540 to about 1560nm, the absorption spectrum exhibiting a lower absorption in the region from about 1540 to about 1560nm than the absorption in the spectral region from about 1530 to about 1540nm and particularly at about 1532nm, one of the input and output ends of said filtering fiber being adapted for connection to a transmission fiber input end;

means for introducing pump light into at least one of the input and output ends of said gain fiber; and

means for introducing a light signal having a wavelength in the range from about 1530 to about 1560nm into the input end of said gain fiber wherein said pump light stimulated emission in said gain fiber over the wavelength range from about 1530 to about 1560nm and an amplified signal in the range from about 1530 to about 1540nm is not attenuated below a level about equal to the magnitude of an amplified signal in the wavelength range from about 1540 to about 1560nm.

45. The amplifier of claim 44 wherein said means for introducing pump light comprises at least two pump sources.

46. The amplifier of claim 44 wherein said amplifier is reverse pumped.

47. The amplifier of claim 44 which further comprises means between said gain fiber and said filtering fiber for filtering light in the pump wavelength spectrum.

48. The amplifier of claim 44 wherein the pump light has a wavelength centered around at least one of about 980nm and 1480nm.

49. (Amended) The amplifier of claim 45 wherein the at least two pump sources have a wavelength centered around at least one of about 980nm and 1480nm.

50. (Amended)The amplifier of claim 45 further comprising at least a second gain optical fiber consisting of one core which contains ions capable of producing stimulated emission of light within the band of wavelengths extending from about 1530 to about 1560nm when pumped with light having a wavelength capable of causing said stimulated emission in said band of wavelengths, said stimulated emission from said gain fiber exhibiting a gain spectrum including a peak around 1532nm and a substantially flat gain region extending from about 1540nm to about 1560nm, said second gain fiber having input and output ends; wherein said at

least first and second gain fibers and said filtering fiber are optically interconnected in a series arrangement.